

## THE HISTORY OF CHANGES IN WATER RELATIONS IN THE CATCHMENT BASIN OF RIVER PIWONIA

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**Summary.** The paper presents the history of changes in water relations in the catchment basin of river Piwonia. The changes in the layout and density of the river network are presented on the basis of topographic maps at the scale of 1 : 100 000 from the period from 1839 to 2009 and melioration plans. In the middle of the 19<sup>th</sup> century the river began on the meadows in the region of the village Górki, and the first melioration works were performed after 1890. After World War I fishpond farming developed in the area, as the existence of fishponds granted protection of estates from parcelling out. At that time 3 complexes appeared, composed of 25 fishponds in Sosnowica, 23 in Libiszów and 7 in Pieszowola. The greatest changes in water relations took place in the period of 1954–1961, when the Wieprz-Krzna Canal (WKC) was constructed, and in the valley of river Piwonia several melioration objects appeared, with surface area of about 4000 ha. In the 1960's a water canal constituting the beginning of Lower Piwonia was constructed, bypassing lakes Łukie and Bikcze from the east and lake Nadrybie from the north.

As a result of hydrotechnical works, the length of the river increased from 40 to 62.7 km, and its beginning was shifted to lake Uściwierzek. The surface area of the catchment basin of the river at the beginning of the 18<sup>th</sup> century was 300 km<sup>2</sup>, while at present, at the beginning of the 21<sup>st</sup> century it is 579.33 km<sup>2</sup>.

**Key words:** network of rivers, Piwonia basin, water relations, topographic map

### INTRODUCTION

Since ancient times water has been considered as one of the elements, the giver of life and death. Descriptions of floods and methods of using water for

military purposes can be found even in the Bible. One of the oldest symbols of regulation of water relations is the system of canals in the valley of river Euphrates, built in the 6<sup>th</sup> century BC. In Poland the first melioration works consisting in building embankments along the bed of the lower Vistula and draining the area of Żuławy were performed in the 13<sup>th</sup> century [Starkel 1991]. Regulation of riverbeds was begun in the 15<sup>th</sup> century, but those works intensified towards the end of the 18<sup>th</sup> century. The regulations consisted mainly in straightening and narrowing of the riverbeds, and in joining lakes for the purpose of water transfers. Water meliorations in agricultural regions were started in the years 1860–1910, but the period of the partitions of Poland was not conducive to development. A certain intensification of such works took place in the years 1924–1931, when about 400 thousand hectares of arable lands were meliorated [Grzyb *et al.* 1982, Lipiński 2003]. The greatest intensification of melioration works took place in the years 1954–1990, the record year being 1972 when 300 thousand ha were meliorated. After 1991, due to a drop in the profitability of farming, there was a regression of melioration. At present 6.6 million ha of arable lands are meliorated, half of which is in need of rebuilding or modernisation [GUS 2012, Tomiałojc 1995]. Certain of the objects have been subjected to the process of restoration and included among the Natura 2000 sites – in unchanged state [Chmielewski 2009].

#### MATERIAL AND METHODS

The catchment basin of river Piwonia is a 4<sup>th</sup> order catchment situated in the drainage basin of river Tyśmienica, wholly within the region of Polesie Lubelskie which is the most marshy macro-region of Poland. The notably large share of bogs in the region, amounting to 42%, and additionally the 62 lakes situated there, create the impression of an abundance of water [Radwan 1994]. That apparent excess of water was the impulse for the implementation of water melioration projects.

The range of transformations of the environment in the basin of river Piwonia was determined on the basis of:

- Quartermaster Map 1839, 1887; Karte von Central-Europa 1873; Reymanns Special 1887, Karte des Westlichen Russlands 1897, 1914; Tactical Map 1936; Übersichtskarte von Mitteleuropa 1900, 1944; Topographic Map 1966, 2009.
- Studies and designs of melioration objects 1963, 1972, 2008.

#### THE HISTORY OF CHANGES

According to the Quartermaster Map 1839, 1887, in the middle of the 19<sup>th</sup> century the river had its origin in the region of the village of Górkki. The second water course of Piwonia Dolna joined the lakes Karaśne, Zienkowskie and Cycowe, while in the region of the village Komarówka there was a mire. According to the

Übersichtskarte von Mitteleuropa 1900, river Piwonia originated from lake Łukie, and there was a connection between lakes Bikcze and Nadrybie. Around the year 1890 the construction of canals joining lake Cycowe with the springs of the river and lakes Bikcze and Nadrybie was completed. As a result of those hydrotechnical works, waters of lakes Bikcze, Nadrybie and Gumienko flew to the catchment basin of river Bobrówka. According to the Karte des Westlichen Russlands 1914, the river had its beginnings in lake Nadrybie – at the beginning of the 20<sup>th</sup> century connections were created between lakes Bikcze and Łukie, and with lakes Uściwierz and Uściwierzek, while the connection with river Bobrówka was partially eliminated.

The development of fishpond economy took place after World War I, as the existence of fishponds provided protection against parcellation of estates. At that time 3 complexes appeared, composed of 25 fishponds in Sosnowica, 23 in Libiszów and 7 in Pieszowola. Die Karte des westlichen Russland 1914, in the area of the ponds, shows wetlands, mostly covered with bush vegetation, with sparse groups of trees. It also shows watercourses indicating water management in lakes Bikcze and Karaśne, as well as now non-existent watercourses in villages Bohutyn and Sosnowica. The largest ponds of Sosnowica were created on the base of those watercourses, through the damming of the valley. Large changes in the fishpond management took place as a result of the construction of the Wieprz-Krzna Canal, where in the 1960's almost all of the old fishponds were modernized, and 5 new ones were built in the village of Górka. According to data from 1973, the area of the 3 pond complexes was 442.88 ha. In connection with the process of overgrowing, that area has shrunk and currently amounts to 380 ha. Out of the 60 ponds existing at that time, now 20 are under proper fish-breeding use, about 35 ponds are abandoned and largely overgrown, and 5 – the smallest ones – have been eliminated.

The greatest changes in water relations took place in the period of 1954–1961, when the Wieprz-Krzna Canal (WKC) was constructed, and in the valley of river Piwonia several melioration objects appeared, with surface area of about 4000 ha. In the 1950's the bed of river Piwonia Dolna was directed to lake Uściwierzek, bypassing lakes Nadrybie and Bikcze, and then also lake Łukie, up to the level of lake Gumienko [Topographic Map 1966]. Further changes took place in the years 1968–1972 and those were related with the construction of the Bogdanka-Wola Wereszczyńska Canal (BWWC) joining WKC and river Piwonia with lake Wytyczno and the catchment of river Włodawka. At that time, melioration objects were built in the valleys of rivers Kodenianka and Konotopa. At present river Piwonia has its origin in lake Uściwierzek, and lakes Nadrybie, Bikcze, Uściwierz, Uściwierzek, that were endorheic lakes in the 18<sup>th</sup> century, have been included into the drainage network. The map of 1839 also shows lakes Lejno and Ciesacin, now virtually non-existent.

At present the BWWC is strongly devastated, and on certain section even filled with rubble. Due to the lack of proper operation and maintenance of the melioration structures, especially within catchment basis there takes place sea-

sonal secondary flooding of the ground. River Piwonia is linked with river Bobrówka via 2 large canals: from the peripheral ditch of lake Łukie, and from lake Gumienko. Lake Gumienko and the former lake Lejno are now included in the catchment basin of river Bobrówka. The catchment basin under analysis is connected, by means of numerous canals and ditches, via river Kodnianka with the drainage basin of river Zielawa, and via river Piskorzanka – with the drainage basin of river Żarnica.

#### THE STATUS QUO

River Piwonia, as the largest tributary, has its outlet to river Tyśmienica, on its right hand side, at 38.09 km, immediately below Pond Siemień. According to the Atlas of Hydrographic Division of Poland [Czarnecka 2005], it has a length of 62.7 km and drainage basin with area of 579.33 km<sup>2</sup>. Harasimiuk *et al.* [1998] report that the length of the river is 59.8 km, drainage basin area is 521.3 km<sup>2</sup>, and the mean gradient is 0.54%. Accurate determination of those parameters faces problems related with the high bogginess and uncertain watershed (melioration ditches connect neighbouring catchment basins). Lakes situated within the basin of river Piwonia include Uściwierzek, Ciesacin, Uściwierz, Nadrybie, Bikcze, Łukie, Karaśne, Moszne, Zienkowskie, Cycowe, Czarne and Białe Sosnowickie, Bialskie, and endorheic lakes Rotcze, Sumin, Płotycze. The watercourse network is anthropogenic-transformed and connected with other rivers. Within the drainage basin of river Tyśmienica there are several watercourses with the name of Piwonia – South Piwonia, Upper Piwonia (tributary of river Bobrówka), Lower Piwonia (fragment below the village Łomnica) and the Old Piwonia (tributary of Tyśmienica) [Michalczyk and Wilgat 1998].

Lake Uściwierzek is accepted to be the origin of the river. Then the bed of river Lower Piwonia was routed bypassing lake Nadrybie from the north and lakes Bikcze and Łukie from the west, up to the point of junction with lake Gumienko (Fig. 1). The whole central section of the river is a man-made trapezoid-section canal built in the nineteen sixties.

Over its central section river Piwonia traverses lakes Zienkowskie and Cycowe, and then flows parallel to the Wieprz-Krzna Canal, beneath which it passes through a syphon at the village of Bohutyn, on the 33<sup>rd</sup> km of the river length. Two large complexes of ponds are situated in that region – in Sosnowica (outlet of river Hetman) and in Libiszów (beginning of Konotopa). In the vicinity of the village Chmielów the river changes its course from meridional to parallel-oriented. In the town of Parczew, at the water-level gauge controlling 72% of the drainage basin, the water flow is 1.5 m<sup>3</sup>/s. Approximately 1 km below Parczew, river Konotopa flows into Piwonia. Konotopa drains an area of 96.37 km<sup>2</sup>, and its source is in the lakes of Sosnowica.

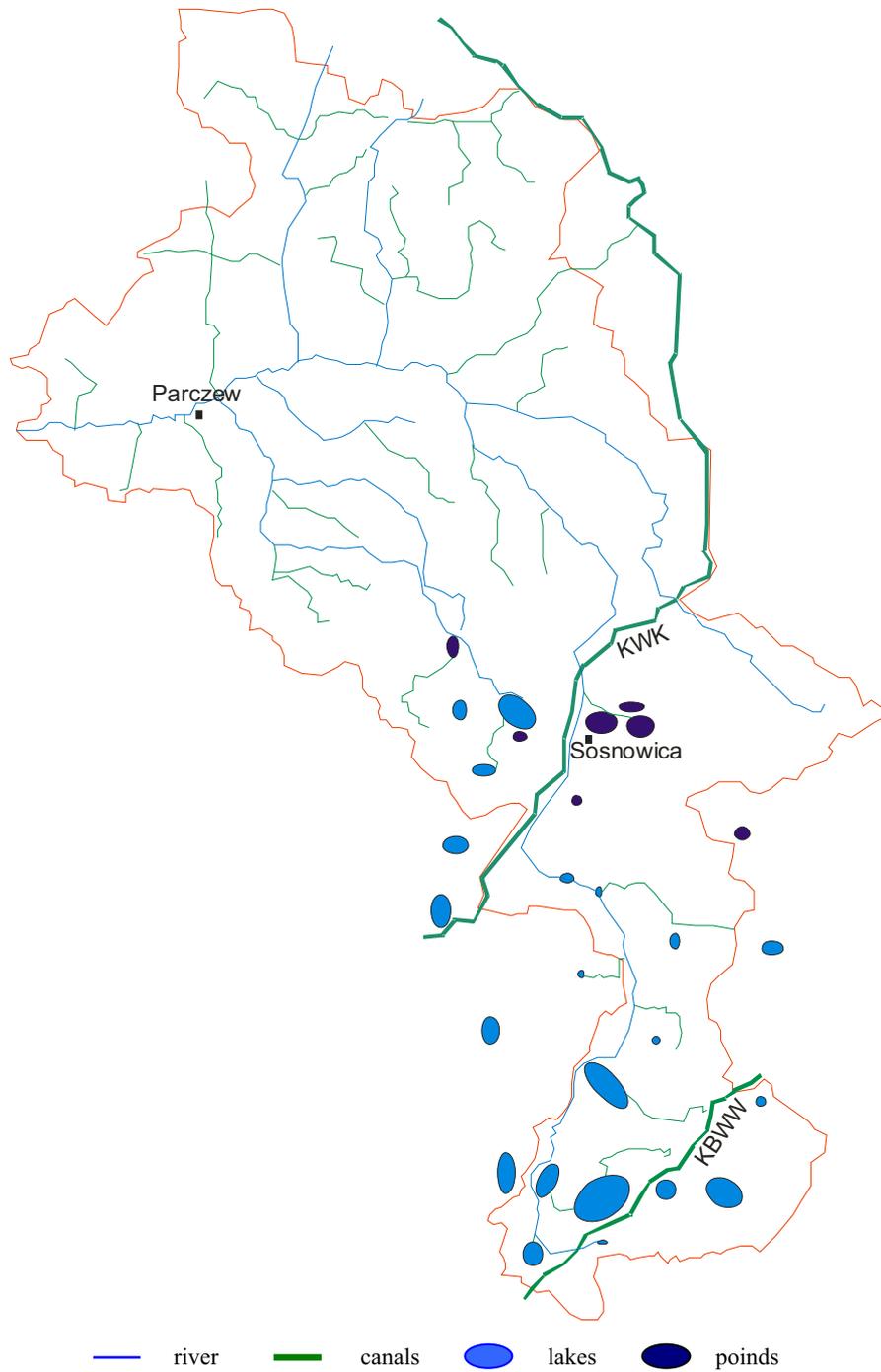


Fig. 1. Basic network of catchment basin of river Piwonia  
[Quartermaster Map 1839, 1:126 000; Topographic Map 2009, 1:100 000]

Table 1. Increase of drainage basin of river Piwonia [based on Czarnecka 2005]

Tributary	Mileage	Length	Fragmentary basin	Basin of Piwonia
Uściwierz (rów)	56.77	1.2 (Uściwierz)	10.48	33.24
Dobra Rzeka	51.54	6.32 (Łukie)	22.85	67.67
Zawadówka	49.42	3.45	6.42	
Ciek Zienkowski	44.92	6.15	17.59	
Staw Hetman (rów)	35.06	3.01 (Hetman)	25.65	
Nietiaha (rów)	26.38	2.7	4.19	
Uhnin (rów)	22.51	6.18	8.17	190.88
Kodenianka	20.84	21.87	67.33	258.21
Strumień Zaniowski	16.62	11.1	45.32	325.71
Piskorzanka	13.25	12.58	79.82	405.53
Kołodziejka	11.05	7.38	17.79	444.62
Konotopa	9.08	19.02 (Białe)	96.37	540.99
Parczew (rów)	7.64	5.09	7.81	
Augustówka	2.65	3.51	11.14	579.33

Table 2. Melioration and watercourse network in communes of the district of Parczew

Commune	Total area, ha	Arable lands, ha	Grass lands, ha	Ponds, ha	Canals, km	Rivers, km	Ditches, km
Parczew	14 623	573	1 607	258	0	46	240
Dębowa Kłoda	18 829	1 873	2 710	118	13.5	47.5	424
Sosnowica	17 235	510	2 539	585	30.2	31.6	322
Razem	50 687	2 956	6 856	961	43.7	125.1	986

At the beginning of the 1990's attempts were made at the restoration of both the riverbed and the melioration structures. The restoration programs implemented in the years 1992–1999 covered the peatbog Ciesacin, lake Bikcze, and the object Zienki with total area of 290 ha. The change of the nature conservation law in 2000 made further realization of the program of harmonisation of nature and the economy impossible [Chmielewski *et al.* 1996, Chmielewski 2009].

The analysed drainage basin of river Piwonia is situated in 80% within the area of the communes Dębowa Kłoda, Sosnowica and Parczew. The remaining small fragments of the basin are situated in communes Jabłoń, Ludwin, Urszulin and Stary Brus. Out of the total area of the communes, amounting to 50 687 ha, meliorated agricultural lands constitute 10 773 ha (arable soils, grasslands, ponds). The total length of the water network is 1155 km (Tab. 2), which corresponds to density of 11 km/km<sup>2</sup>.

## RECAPITULATION

River Piwonia, currently draining lakes, in the middle of the 19<sup>th</sup> century had its origin in meadows in the region of the village of Górkki, and the length of the river was 40 km [Map 1839]. At the end of the 19<sup>th</sup> century the construction of a network of regulation canals caused a shift of the beginning of the river by 10 km to the south of lake Łukie, and the length of the river increased to 52 km [Map 1900]. At the start of the 20<sup>th</sup> century the connection of the other Uściwierskie Lakes with a canal caused that river Piwonia began from lake Nadrybie and flew through the remaining lakes, and the length of the river increased to 57.4 km [Map 1915]. In the 1960's, the water canal constituting the beginning of river Lower Piwonia was routed to bypass lakes Łukie and Bkczce from the east, and lake Nadrybie from the north [Map 1966]. As a result of the hydrotechnical works, the length of the river increased to 62.7 km, and its origin was shifted to lake Uściwierzek [Czarnecka 2005].

The area of the drainage basin at the beginning of the 18<sup>th</sup> century was about 300 km<sup>2</sup>, and now, at the beginning of the 21<sup>st</sup> century it is 579.33 km<sup>2</sup>.

Apart from the changes in the length of the river, there were also changes in the use of the bottom of the valley. The first important change was the construction, after World War I, of the fishponds in Sosnowica, Libiszów and Pieszowola, replacing former tree stands. In the nineteen sixties also the ponds in the village of Górkki were built. At present, a half of the ponds existing then is out of use, and only the largest ones and situated the closest to the WKC are still functioning.

The analysed drainage basin includes 3 large complexes of fishponds – Sosnowica, Libiszów and Górkki – and several small ones with a total area of 450 ha. At present only one half of the area of the ponds is used for fish production, the rest being abandoned while the smaller ponds have been backfilled.

The second largest in history change in the water relations was connected with the construction of the WKC, WBWC and of the dense system of melioration ditches in the years 1954–1973. At present, in the drainage basin, mainly in the river valleys, there are over a dozen melioration structures with a combined area of about 8000 ha. The WBWC is in a state of total neglect, frequently largely overgrown and even filled with rubble. Also the network of detail ditches with the hydrotechnical structures have not seen any maintenance since 1998. As a result of silting up of ditches and culverts, secondary flooding of the ground and the succession of ruderal vegetation is observed at many places.

## CONCLUSIONS

1. The first hydro-technical works near Uściwierskie Lakes were performed in 1890–1910, and they consisted in making canals connecting different lakes.

2. As a result of the hydrotechnical works, the length of the river increased in 40 to 62.7 km in year 1839–2009, and its origin was shifted to lake Uściwierzek.

3. Largest in history change in the water relations was connected with the construction of the Canals and of the dense system of melioration ditches in the years 1954–1973. At present, in the drainage basin, mainly in the river valleys, there are over a dozen melioration structures with a combined area of about 8000 ha.

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#### HISTORIA ZMIAN STOSUNKÓW WODNYCH W ZLEWNI RZEKI PIWONIA

**Streszczenie.** W pracy przedstawiono historię zmian stosunków wodnych w zlewni rzeki Piwonii. Na podstawie map topograficznych w skali 1 : 100 000 od 1839 do 2009 roku oraz projektów melioracyjnych przedstawiono zmiany układu i gęstości sieci wodnej. W połowie XIX wieku rzeka zaczynała się na łąkach w rejonie wsi Górki, a pierwsze prace melioracyjne wykonano

w 1890 roku. Rozwój gospodarki stawowej nastąpił po I wojnie światowej bowiem istnienie stawów chroniło majątek przed parcelacją. Wówczas powstały 3 kompleksy, które tworzyło 25 stawów w Sosnowicy, 23 w Libiszowie i 7 w Pieszowoli. Największe zmiany stosunków wodnych zaszły w latach 1954–1961, kiedy to wybudowano Kanał Wieprz-Krzna (KWK), a w dolinie Piwonii powstało kilka obiektów melioracyjnych o powierzchni około 4000 ha. W latach 60. kanał wodny, stanowiący początek Piwonii Dolnej, poprowadzono omijając od wschodu jeziora Łukie, Bikcze i od północy Nadrybie.

W wyniku prac hydrotechnicznych długość rzeki wzrosła z 40 do 62,7 km, a jej początek przesunięto do jeziora Uściwierzek. Powierzchnia zlewni rzecznej na początku XVIII wieku wynosiła 300 km<sup>2</sup>, zaś obecnie na początku XXI wieku wynosi 579,33 km<sup>2</sup>.

**Słowa kluczowe:** zlewnia rzeczna, Piwonia, stosunki wodne, melioracje wodne